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Minerals of the Thomas Range, Utah

By ARTHUR MONTGOMERY

The Thomas Range is one of the most uniquely interesting of all American mineral localities. Yet a remote location in the barren, desert country of west-central Utah has kept it from receiving much attention either on the part of scientists or collectors. Thus, although it was known to be a remarkable topaz locality well over fifty years ago, there has been very little written on the mineralogy of the area and the number of visitors to the range has not increased during recent times.

It is the purpose of this article to give a brief picture of the geology and mineralogy of the Thomas Range, as well as to tell the experiences of a month's collecting in that region during the late spring of 1934.

Geography, History and General Geology

The Thomas Range is one of many small mountain ranges which rise abruptly out of the flat, desolate landscape just south of the Great Salt Lake Desert. It is one of the most isolated sections of western Utah, with few roads and still fewer inhabitants. The nearest town is Delta, about forty-five miles south-east of the range.

The best route out to the range is complicated and still difficult to negotiate successfully. Delta is the starting point, and a fairly distinct road leads west and north-west, first through the fabled and nearly invisible hamlet of Abraham, then around the western borders of the Drum Mts. to a now deserted place called Joy and approximately ten miles south of the range. There is a well at Joy, and it is the last drinking water that may be obtained. From Joy it is necessary to pick out the most likely route from amongst the numerous wagon tracks leading in every direction across the desert. Even from this distance the whitish rhyolite of the Thomas Range is distinguishable from the darker colored rocks of adjacent mountains, and the lofty peak of Topaz Mountain in the south-east corner of the range is an added landmark.

The main body of the range runs in a general north-south direction, and takes the shape of an elevated, much-dissected plateau rather than a central ridge system. The highest part of the range is along the eastern side, with Topaz Mountain reaching an altitude of 7,100 feet. Steep and lofty cliffs face to the south and along much of the western section, and the topography everywhere is broken up into a maze of narrow ridges and winding canyons. The length of the range is about 15 miles, with a width varying from 5 to 8 miles. The topographic map shows several isolated but adjacent mountain masses on the west as included parts of the range proper, but this article will deal solely with the main central body of the range, delimited on the west by the road leading to Wildhorse Spring and on the north by the so-called Dugway road.

According to Patton,[1] the Thomas Range was known to be a topaz locality as early as 1859, but it was not for thirty or more years that any serious collecting trips were made to the area.

1 Patton, H. B., Bull. Geol. Soc. Am., Vol. 19, 177 - 192, 1908.

Among the most active of the early collectors to visit the range were Maynard Bixby and H. B. Patton. It was Bixby who first carried out extensive exploration in the range and discovered the red beryl and the rare mineral to be named after him, bixbyite. Patton wrote the first general article on the geology and mineralogy of the area.[2] Collecting within recent years seems to have been almost at a standstill. It has been in the past two summer seasons of 1933 and 1934 that the writer and Edwin Over, Jr. have carried out, both separately and together, an extensive program of collecting and exploration throughout the range. This work alone has formed the basis for the present article.

Geologically speaking, the main body of the Thomas Range is built up of a series of lava flows. Although there are underlying andesites, darker-colored and making up the lowlying outer foothills, the omnipresent lava of the range is a gray-white to white rhyolite. This rhyolite extends northward into the adjoining Dugway Range for several miles, and further evidences of it are to be seen in nearby ranges to the east and west. Underlying the lava flows are some limestones which are exposed in the Dugway Range, also in outlying western parts of the Thomas Range.

The rhyolite is of a highly-acidic character, composed essentially of alkaline feldspar and quartz, and wholly lacking in ferromagnesian minerals. The texture is quite fine-grained, though it may vary from a compact and dense rock of a darker gray to one of a more crystalline character and lighter color. Where the rhyolite is whitest and most coarsely crystalline, the rock is filled with lithophysal cavities. These lithophysae are built up of concentric and rather thin, shell-like walls which are coated with tiny quartz crystals. Such cavities are generally small, but they may attain very large size in some instances. Rarely, isolated masses of a smooth and very fine-grained, grayish tuff are to be seen in the rhyolite, and these presumably have been caught up in the later flow of lava. Flow structures are common and often very well shown.

The weathering of this rhyolite is one of the most striking features of the Thomas Range landscape. Being quite soft and friable, it offers practically no resistance to erosion. Parts of the rock weather out faster than others, and the whole process is so rapid that exposed surfaces become hollowed out into great circular caves and depressions with weirdly overhanging roofs which stand out from the steeper cliffs in every manner of curving, grotesque shape imaginable. But this rapid erosion also helps to clean up the landscape of lower rock surfaces in a remarkable fashion, for all the eroded and broken-down blocks soon disintegrate entirely into sand and dust which the wind blows away.

2 Patton, H. B., loc. cit.

Mineralogy

The mineralogy of the Thomas Range rhyolite is unique. It would still be unique if topaz were its only well crystallized mineral, for there is surely no known occurrence where this fairly rare silicate is concentrated in such quantity throughout an extensive formation. Other occurrences of topaz in rhyolite, as at Nathrop, Colorado, and San Luis Potosi, Mexico, are decidedly limited in comparison.

Although topaz is found in great quantity throughout most parts of the Thomas Range, it is in the vicinity of Topaz Mountain that crystals occur in richest abundance. The ground is literally covered with them, millions and millions of crystals and crystal fragments reflecting the sunlight in countless, flashing reflections. It is mute evidence of the all-powerful work of erosion in this region; yet the numbers of crystals remaining unweathered from the rhyolite must be far more limitless still.

There are other minerals found associated with the topaz, and the list of these adds decidedly to the uniqueness of the Thomas Range mineralogy. The garnet and hematite are not unusual, but the pseudobrookite and bixbyite are exceedingly rare species, and the red beryl is absolutely unique in its occurrence. The following minerals have been found thus far to occur in the Thomas Range rhyolite:

1. Orthoclase
2. Quartz
3. Topaz
4. Hematite
5. Garnet (Spessartite)
6. Bixbyite
7. Pseudobrookite

8. Beryl
9. Calcite
10. Fluorite
11. Hyalite

Before discussing each of the minerals in turn, it is well to outline briefly the general type of mineralization which must have taken place in the rhyolite. At the starting point there is the last and uppermost flow of lava. As this highly acidic rhyolite begins to cool and solidify from the molten state, the mass is honeycombed with gas bubbles or vesicles. These vesicles remain as free openings during and after the consolidation of the lava. During consolidation, it was in these openings that the topaz and its associated minerals found room in which to crystallize. And the formation of the topaz was thus brought about by pneumatolytic action, due to the interaction of the gasses with certain elements of the rhyolite magma. With fluorine from the gasses, and borrowing aluminum and silica from the alkaline magma, the crystallization of this aluminum fluo-silicate was allowed to take place.

That the crystallization of the topaz occurred while the rhyolite was still molten, is well shown by the character of those crystals which formed partly projecting into lithophysal cavities, this part of them being transparent, and partly embedded in the surrounding rhyolite, this part of them is opaque by the inclusion of quartz crystals borrowed from the rhyolite. Opaque crystals are also found completely embedded in the rhyolite, perhaps even more striking evidence.

1. **Orthoclase:** In addition to composing an essential part of the rhyolite ground-mass, generally as highly kaolinized alkaline feldspar, microscopic, perfectly-formed crystals of glassy orthoclase are found in lithophysal cavities as a rather infrequent occurrence. Association is with quartz and topaz.

2. **Quartz:** In addition to making up an essential part of the ground-mass of the rhyolite, in the form of blebs or grains, quartz is found typically in microscopic or very small bipyramidal crystals lining the thin, shell-like walls of the lithophysal cavities or incorporated directly into the opaque topaz crystals. At a few localities in the range slightly larger crystals are found in lithophysae, these often of a pale bluish color.

3. **Topaz:** The topaz of the Thomas Range rhyolite occurs in opaque as well as transparent crystals. The transparent crystals are sharply formed, of superb brilliance undiminished by any amount of surface exposure. and originally of a beautiful sherry-yellow color. This color is completely lost after much exposure to light and heat. In size the transparent crystals average perhaps ¼ inch in length, though they have been known to reach a full inch and more.

The opaque crystals are of this character due to the inclusion during crystallization of countless, minute quartz crystals. They are typically rough in appearance, with prisms better developed than terminations, and are found together in irregular radiating groups in the walls of cavities and directly in the solid rhyolite. The size is much larger than in the transparent crystals, with the average length from one to over two inches. Rarely, perfectly smooth opaque crystals are found. these owing their sharper crystallization to the less resistant character of the soft, fine-textured tuff in which they were allowed to form.

In habit the transparent crystals show a fine development with many faces, yet the form is never very complex. Generally there are 2 prisms, 3 and 4 pyramids, 2 brachydomes, 1 macrodome, and with or without base. The opaque crystals, never allowed much room in which to crystallize and interrupted in development by inclusions of foreign matter, show the simplest form possible. There is usually just a prism development, with roughened and incomplete terminations.

4. **Hematite:** Hematite occurs in tiny paper-thin plates (rarely in indistinct and minute crystals of rhombohedral shape) in lithophysae and irregular cavities of the rhyolite. Formation must have occurred almost simultaneously with topaz, for hematite plates are often found partially included into topaz crystals. A secondary hematite is also found encrusting the surfaces of altered garnet.

5. **Garnet (Spessartite):** Garnet is a far commoner mineral of the Thomas Range rhyolite than has been hereto-

fore supposed. It occurs typically in rough cavities of the rhyolite, not lithophysae, and is generally of a roughened and altered appearance in rounded crystals. Now and then crystals of fresher composition are found; these are opaque and dark reddish-brown to black in color and of trapezohedral form. Original composition is undoubtedly that of spessartite. while the roughened crystals may be partially altered to quartz, topaz, hematite, and other minerals. The size of the crystals is usually about ¼ to ½ inch in diameter, though some altered crystals have been found over two inches across.

The garnet crystals occur typically alone in the rhyolite, but at times they are associated with topaz. Tiny topaz crystals are found coating the surfaces of some garnets, and at one locality are found to be grown in definite orientation with the crystal form of the garnet.

6. **Bixbyite:** Bixbyite, an oxide of iron and manganese, is found at widely scattered points in the range, but in large distinct crystals at only one limited locality.[3] Here the cubes may reach a size of ¼ inch in diameter, though the average size is less than ⅛ inch. Crystals are of simple cubic form, or cubes modified by the trapezohedron. The color is black, and the luster metallic. In occurrence the crystals are found either grown upon topaz or altered garnet, or directly in the rhyolite. Bixbyite is a very rare mineral, and has only recently been reported from one or two foreign localities in limited amounts in addition to the Thomas Range occurrence and a reported locality in New Mexico.

7. **Pseudobrookite:** Pseudobrookite, an oxide of iron and titanium, is one of the rarest minerals of the Thomas Range rhyolite, and is the one most recently discovered.[4] As in the case of the bixbyite, large distinct crystals are found at only one locality. The form is in thin prismatic crystals, often acicular in shape. The color is gray-black, and the luster is brilliant metallic. The largest crystals rarely reach an inch in length. The crystals occur in radiating groups, lining the sides of lithophysae and irregular cavities of the rhyolite. Pseudobrookite is also a very rare mineral and is reported from only a few foreign localities in addition to this and one other American occurrence.

8. **Beryl:** Beryl is found in the Thomas Range rhyolite as small crystals of a typical pinkish to raspberry-red color. It has been found here only recently in some quantity. The crystals are tabular in shape, consisting merely of the hexagonal prism with base, and average about ¼ inch in diameter. Occurrence is in the lithophysal cavities, and on topaz crystals rarely. Both bixbyite and pseudobrookite are found associated with the beryl in some instances. The color has been shown to be probably due to the presence of manganese as an impurity,[5] and in this connection it does not seem unlikely that the manganese comes from the associated bixbyite. Perhaps the most interesting phase of this beryl occurrence is the problem of the genesis, and the reasons for its formation in such an unusual and unsuited environment as the rhyolite. So far as the writer knows, there has never been another reported occurrence of beryl in a lava.

9, 10 and 11. The calcite, fluorite, and hyalite of this rhyolite occurrence are found as rather rare minerals of late formation. The calcite is found at several localities in veinlets and as the lining of small cavities in the rhyolite. Frequently it has formed around the earlier topaz crystals which project into these cavities. The calcite is rather flaky and pure-white in color, and shows rare signs of vaguely-crystallized hexagonal plates. The fluorite is associated with the calcite in very small amounts, and of a light purple color. The hyalite is found here and there as a very thin, almost invisible, glassy coating on surfaces of the calcite. It fluoresces a bright green under the ultra-violet light.

Field Work of 1934

Edwin Over and I reached the Thomas Range about May 1st. Our plans were (1) a week of exploration on the eastern side of the range, including a visit to the bixbyite locality, (2) several weeks of blasting for topaz and red beryl in the vicinity of

3 Montgomery, A., *Am. Min.*, 19, pp. 82 - 87 134.

4 Palache, C., *Am. Min.*, 19, pp. 14 - 20, 1934.

5 Hillebrand, W. F., *Am. J. Sc.*, 19, pp. 330, 1905.

Topaz Mountain, (3) final exploration on the west. This program called for a month of hard work and concentrated effort, since we wished not only to cover much unexplored territory but also to collect many really fine specimens. Current ideas to the contrary, the latter can be accomplished at most present-day localities only with the aid of considerable dynamite, back-breaking labor, and patience. And of these three, the third is probably the most important.

After reaching Topaz Mountain, we headed directly up the eastern side of the range. Two rather vague wagon ruts made the going possible but precarious, and they led us first among huge boulders and then into sandy and alarmingly steep cross-washes. We pitched camp in a large canyon about two-thirds of the way up this side of the range. From here it was not more than a mile to the bixbyite locality, where we spent several days picking up the black cubes of bixbyite, well-formed crystals of smooth, opaque topaz, and several red beryl specimens. Blasting didn't help much, and we found practically no specimens in place. Among other finds, we discovered a number of scorpions who had been sleeping peacefully beneath their rocks, and who objected most strenuously to our intrusion.

From the bixbyite locality we commenced to work back towards Topaz Mountain, exploring well into the range and covering much unexplored ground. On one of these exploring trips Edwin Over made a find of major interest. While examining the bare rock surface beneath steeply-inclined cliffs, he picked up a few minute black needles which he recognized as pseudobrookite. Fortunately it was he who had during the previous summer discovered the first microscopic crystals of this rare mineral ever found in the Thomas Range[6]—it was, indeed, the second reported American occurrence. Now climbing the steep cliffs just above this spot, Over was soon able to locate the place where the new pseudobrookite had weathered out of the rock. Here the rhyolite was so pitted and seamed with lithophysae and cavities of all descriptions that it seemed a veritable sponge. Some of the cavities were devoid of any mineralization; others had attached to their sides groups of radiating pseudobrookite

6 Palache, C., loc. cit.

Topaz Mountain from the Southeast

crystals and paper-thin plates of hematite. In rare cases these pseudobrookite crystals reached a length of one inch and so far as sharpness, development, and general perfection of crystal form are concerned probably represent the finest specimens of this rare mineral yet found anywhere.

About this time we began to find garnets. They were generally crystals of small size and roughly-weathered appearance. Some were very large, and altered on the surface to hematite. A few here and there seemed fresh, occurred in distinct trapezohedrons, and were reddish-brown to black in color. Although they lacked quality, quantity was theirs. They seemed to be everywhere, not only in this section, but soon to be found in even greater numbers in the south and west. To me this abundance of garnet crystals is just another indication of the largely unexplored character of the Thomas Range. Up till now garnets have been reported as rather scarce in this region, except for one or two limited occurrences. but we found the crystals in such numbers throughout the range that they must be regarded as a very common mineral of the locality. It is surely unfortunate that they are typically of such poor quality.

Nothing more of note was discovered on the way south to Topaz Mountain. Now began a two weeks' period of real labor. A local friend of ours joined us from the south, and armed with dynamite, drills, chisels, and a mighty 10-pound sledge, we fell upon the rhyolite with a vengeance. We were after the deep-colored topaz crystals in the matrix of rhyolite, and would not be satisfied with anything but the best. And the best here are truly superlative, for there are few mineral specimens so beautiful as the perfectly-formed topaz crystals of rich wine-yellow color embedded in a background of gray-white rhyolite, or better still, pure-white calcite.

We had this calcite to thank for the excellence of the locality we were working. Over had noticed thin veinlets of secondary calcite in the rhyolite here, and finding plentiful indications of topaz also, had decided that the two would make a good combination. He was right, and many of our finest specimens showed topaz crystals embedded in the calcite. Not only did the pure-white background help to bring out fullest tints of color in the crystals, but as a surrounding matrix it preserved perfectly the sharp and fragile form.

Our division of labor gave the drilling and blasting to our friend Louis, wielding of the 10-pound sledge hammer to Over, and smaller trimming to me. To my lot also fell the unenviable task of wrapping the specimens in tissue and newspaper, as quickly as they were found. This was as much to protect the fragility of the specimens as to guard the crystals from the hot glare of the sun and keep them from losing some of their deepest color.

The well-distributed and well-timed "shots" would throw out on the floor of our rapidly growing quarry great blocks of the solid rhyolite. These had to be broken down to quite small sizes so that we would miss no smallest cavity or veinlet with accompanying crystals. Often the blocks would yield nothing at all in their interior. Sometimes there would be hidden cavities springing into view like magic as the rock split open, some disappointing us with their emptiness, but others showing crystals of great beauty. Frequently the calcite veinlets would extend throughout a good portion of certain blocks, and then we would chisel painstakingly along the seam for signs of crystals.

There was one large block, weighing over a hundred pounds, which showed few indications of cavities or calcite upon its outer surface. The sledge descended upon it, and with the one blow the block split directly through the middle as though sheared with a knife. There before our astounded gaze was a nice, symmetrical cavity in the very center of the mass, and, perfectly exposed in that cavity, a crystal of extraordinary size and color. It was one of the finest Thomas Range topaz specimens we had ever seen, and was surely a delight for sore and tired eyes. It was not quite so delightful, however, where we tried to wrap up and carry away such a sizeable piece of rhyolite, for we did not dare to risk the dangers of splitting down further. Finally, several days later, we were able to squeeze it into a specially constructed box, ignobly surrounded by old gunny sacks, articles of clothing. and every nondescript sort of wadding we could find. It made the

trip east successfully, and may be seen now in the National Museum.

Our work on the topaz specimens did not end at the quarry, for most of them were still much too large for packing and shipping all the way back east. We had to haul them over to a little cabin, many miles south of the range, and there, with the aid of Over's rock trimmer, cut off every fraction of superfluous rhyolite that could be safely managed. This was delicate work and, needless to say, not every specimen split just where we wanted, and not every crystal stayed securely fastened to its resting place. But there were not so many casualties at that. This was because Over still could perform wonders with an apparatus that for inadequate parts, looseness of action, and general failure of operation far surpassed anything I have ever seen before or since. Most disconcerting of all perhaps, was the infernal machine's habit of falling neatly and completely apart after every operation.

Next we visited the red beryl locality, a precarious spot high up under beetling cliffs, and another of Over's finds of the previous summer. Here we must blast also, but into a spongy, vesicular rhyolite especially rich in lithophysal cavities. Unfortunately the little tablets of red beryl occurred in cavities very far and few between, and even with such a unique color proved exceedingly difficult to locate. The rock here was granular and gritty to the touch; thus after much work our hands looked and felt as if rubbed down with sand paper. Microscopic needles of pseudobrookite showed up now and then, these representing the locality where first discovered in the range. What a difference now, to see these tiny needles and compare them mentally with the half-inch long crystals from the new locality.

Now and then we relieved the monotony of hunting for red beryls by trying a little exploration within a near radius of Topaz Mountain. But aside radius of Topaz Mountain. But aside very smooth, opaque topaz, and a few very large altered garnets, this search proved fruitless. This is the one section of the entire range that has been pretty well covered by collectors, and does not deserve the attention of the more remote areas.

With really excellent specimens of bixbyite, beryl, pseudobrookite, and topaz tucked away in our belts, so to speak, we could now afford a final week of exploration along the west side of the range. This section, next to the central parts, offers the most virgin hunting ground of all to collectors. The single road which the map shows as running north along this section as far as Wildhorse Spring, is hardly entitled to such a name. It is rather the way of least resistance, this being a winding, soft and sandy wash which skirts the outer edges of the foothills. It is not advisable to attempt this wash with anything less than a powerful truck and an experienced driver. Even then, after successfully negotiating this route, it is impossible to get very near to the lofty rhyolite cliffs which border along the main body of the range. All of which helps to explain why the western section has been so little explored.

We did not by any means cover all the ground we had hoped to explore, but we did get over a good piece of

Our Topaz Quarry

this western section. We found nothing of spectacular interest in our search, but we did discover signs of rich mineralization at widely scattered points. Not only did we collect good crystals of topaz, bixbyite, and red beryl, but we found the finest garnets of our entire work in the range. Some were nearly an inch in diameter, and often quite sharply formed. Practically all were loose crystals, as a result of weathering from the rhyolite, and it was rarely indeed that we found matrix specimens. In addition to the garnets, we came across an area where there was a good deal of black obsidian in association with flows of andesite and rhyolite. Some of the rock surfaces showed thin coatings of glassy hyalite, which material gave later a strong greenish fluorescence under the ultra-violet rays.

Although we covered a lot of new territory, and arrived back in the Drums with a truckload of specimens, this last exploring trip served chiefly to instill in us the desire to return yet again and go on from where we had left off. For with all the work that has been done in the past in the way of exploration, from the haphazard wanderings of the sheepherder and the prospector to the more painstaking researches of the scientist and collector, the Thomas Range still stands as much a lonely, unfrequented, and unknown landmark as when the first expedition sighted it nearly a hundred years ago. And because it stands in a desolate region, waterless, trackless, and uninhabited by any life, it is likely to remain so for future time.

Some Iron Occurrences of West Virginia

By WM. C. McKINLEY

West Virginia contains many deposits of metallic iron ore, besides the brown iron ore which has been mined there since the late 18th century. Although the latter low-grade deposits would cost too much to mine profitably at present, the metallic hematite formations of the eastern mountain border can be salvaged with success, West Virginia, contrary to some reports, has a fair supply of iron ore for the future!

The minerals which compose the iron ores of this state, are.

Limonite
Hematite (metallic)
Hematite (fossil ore)
Siderite (typical)
Siderite (black band ore)

Limonite deposits, which are found with soft hematite, also, occur in the eastern half of the state, where, also are found both metallic and fossil ore hematite. Siderite (typical) occurs more in the central section of West Virginia, in a strip of land extending northeast and southwest; a description of some of these deposits is interesting.

At Quarry Run, the ore is chiefly hematite and siderite, the latter mineral occurring as blue nodules, fine-grained, and covered with a rich scale of iron oxide. On Anthony's Creek, the fossil and block ores make their appearances. At one point, the fossil ore is nine inches thick, but the block ore has been opened at two places, each showing seven feet.

Brown hematite is found as loose boulders over the surface of the ground along the eastern slope of New Creek Mountain, and especially in the vicinity of Greenland Gap. Blocks of the same kind of ore are found on both slopes of Patterson Creek Mountain.

One of the earliest iron furnaces in West Virginia was built at Clarksburg. This was for the use of so-called "ball ore," found in the shales below the Pittsburg coal. The siderite occurred in concretions, containing a low percentage of iron. And in Wayne County, eight seams one to three feet in thickness are known on Big Sandy river, at Cassville. A similar ore is known, locally, at the Clippart seam, as "Olyphant blue lump," due to its use by Olyphant in the Fairchase furnace.

Clinton iron ore has been traced, in the South Fork Mountain, for a distance of 24 miles, by outcrops and loose pieces of float ore, indicating the presence of the bed, the maximum width of which is 30 inches. Such an ore reserve is, undoubtedly, of much real value for future usage.

Titanium at Magnet Cove, Ark.

By CLARENCE L. BROCK

While on a collecting trip to Arkansas, I stayed for two weeks at Hot Springs and collected at Magnet Cove, Crystal Springs, Caddo Gap, and other places in that vicinity, and had the opportunity of visiting one of the very few titanium mines in this country. Titanium ranks ninth as one of the most abundant elements of the earth. Rutile and Ilmenite are the two most important titanium minerals of commercial importance; Brookite, Arkansite, and other titanium minerals not being found in large enough quantities to be of any great value except to collectors.

Rutile occurs as a tetragonal crystal, usually having a dark reddish-brown or black color, a hardness of 6 to 6.5 and the high specific gravity of 4.18 to 4.25. Its chemical formula is titanium dioxide, TiO_2, oxygen 40 per cent and titanium 60 per cent. Rutile is insoluble in acids and infusible before the blowpipe.

The chemical inertness of titanium and the difficulty of breaking down its natural minerals, prevented for a long time any important industrial use of the metal. Recent chemical inventions and improved methods of manufacture have overcome these problems, and have created a new industry; that of titanium pigments. There are many uses for titanium, besides paint pigments, such as for ferro--titanium, smoke screens, are lamp electrodes and chemicals. Titanium is also used to give a natural color to false teeth. However 90 per cent of all that is mined is now used in the manufacture of paint pigments.

The rapidly growing demand for titanium has caused an increased production of Rutile and Ilmenite. The chief producing regions of Rutile in this country, are in Nelson County, Virginia; Mineral City, Fla., and Magnet Cove, Ark.

Many specimens were collected in the Magnet Cove district, but up to 1913 there was not much prospecting and there being little demand at that time, prospecting was abandoned. In 1931, prospecting was again taken up, a company formed to mine titanium, and a mill built capable of handling 40 tons per hour. The first carload was shipped in May, 1932, and the complete output, I understand, is now being taken by one of the large pigment manufacturers in Wilmington, Delaware.

Rutile, Brookite and Arkansite crystals may be found in the beds of all streams flowing into Cove Creek, but they have been picked so close, that good specimens are rare. The best crystals are found in a sandstone that borders the eastern edge of the Cove. One well known spot for rutile crystals is called Perofskite Hill, which is slightly southwest of Cove Creek. Here fine twins are found, called by the dwellers there, sixlings and eightlings.

Where the Rutile stops, odd shaped masses of leucite porphyry appear, and sometimes fine leucite crystals are found. The deposit covers a slightly curved belt of land about 4,000 feet long and 2,500 feet wide. The Cove also contains in this area, clayey soil of dark red color and mixed in this clay are many rutile crystals. It is from this clay the rutile which is now being shipped, is washed. As much as 8 per cent of the soil is Rutile, but in veins it is found to be as rich as 20 to 25 per cent Rutile.

It is said that there is available in commercial quantities, from 50,000 to 60,000 short tons from the few feet of alluvial soil alone. A magnetic separator has solved the problem of separating the other minerals from the Rutile.

Of course, Rutile, Brookite and Arkansite are not the only minerals found here that are of interest to collectors. There are also Dysanalite, Eudialite, Nephelite, Magnetite Xls, Aegerite, Melanite, Ozarkite, etc., but only Rutile is mined commercially.

Mexican Amber

By JOHN BUDDHUE

Strictly speaking amber refers only to one of four fossil resins found in or near the Baltic Sea. This one is distinguished from the others, and from most other fossil resins, by the presence of from 3 to 8 per cent of succinic acid. Nevertheless amber is often taken to mean any of the resins which contain this acid and it is in this sense that it is used here.

It has been known for some time that one or more amber like resins are found in Mexico. Kunz[1] records that it is plentiful in the interior of the southern part of the country. It is said to be of a rich golden yellow color and highly fluorescent when exposed to ultra violet light. It seems that osseous varieties do not occur as it is clearly stated that it is perfectly transparent.

Williamson[2] states that it is mined in the department of Simojovel, State of Chiapas. It is said that the amber bearing area includes a whole mountain bordering on the Huitapan River and that the amber was discovered when the river washed it out of the surrounding deposits during a period of flood. The amber itself is said to be red, yellow, and even black but no further information is given.

The same authority (p. 81) mentions a few beads the color of tortoisshell from Guatamala but beyond suggesting that they are not true amber because the specific gravity (1.263) is too high, he does not describe them further.

It has been stated that amber was found in the bottom of the sacrificial well at Chichen Itza when it was dredged for treasure but it may be that the resin found was copal which differs markedly from all forms of amber.

A short time ago while in Mexico City I saw what looked like two small napkin rings among the treasures of Monte Alban. They were labeled "Amber" and bore some resemblance to that substance. They were a deep rich red color and were filled with cracks resembling crackled glass. Of course no further examination was possible, but it shows that amber, or substances resembling it were known even in ancient Mexico.

I also saw a fragment of opaque cream colored resin from Oaxaca. The exact locality was not known and an examination was not possible as the piece had already been worked into a setting for a ring but it appeared to be a piece of osseous or bony amber.

After much difficulty I secured some samples of amber from Baja, California. So far as I can determine no description of amber from this locality has ever been made and as it does not correspond in properties to any other fossil resin it seems that a description is desirable.

It is mostly clear and of a fine amber yellow color though some is opaque and bony while others contain clots or nodules of the bony variety which are sometimes rather sharply differentiated from the clear form and sometimes grade insensibly into it. In other words, there are all gradations between perfectly clear and entirely bony amber. The latter is usually of a much lighter color than the clear being, in some cases, nearly white like the so-called ice-colored amber of the Baltic Sea. I saw one piece which contained a number of cracks which were wholly confined to the interior of the resin as none of them reached the surface.

The surface of the amber is smooth or slightly pitted as though it had dropped upon small stones while still plastic and in some cases there are grooves which suggest that the piece had been made up of several successively smaller flows. From the appearance I believe that the resin is found either in water or in deposits of very recent origin as there is no trace of the crust often found on succinite and other fossil resins which is due to the action of air upon the surface. Succinite which is found in the sea lacks this crust, probably because it is worn off as fast as it forms and the resin in consequence has a surface like very finely ground glass. Mexican amber also has this appearance. However in the bottoms of some

1 Am. J. Sci., 38, (1884) 73.
2 "The Book of Amber," p. 194, Ernest Benn Ltd., London, 1932.

unusually deep pits I detected traces of a white crust which was entirely different from the "verwitterungs-rinde" which covers most of the Baltic amber.

Enclosures seem to be uncommon as only one of several fragments had any. This one was an insect of a whitish color without dark markings of any kind, even the eyes being white or pale yellow like the rest of the body. I am not zoologist enough to identify it but it bears a rather close resemblance to a bee although it is only about the size of a common house fly. The wings are small, and appear to have smooth edges. They are held as though the insect were in flight and the attitude of the legs suggest this also. There is also another insect with some resemblance to a grub but it is very small and rather deeply buried in the resin.

An accurate determination of the specific gravity of Mexican amber is not possible at present but it can be said that it is less than that of several samples of Baltic amber as it will float in a salt solution which just fails to support succinite. It must therefore be near 1.05.

The hardness is also less than Baltic amber as it will not scratch any of several samples of succinite but they were able to scratch it with a little difficulty. The hardness must consequently be near 2.5.

Like succinite it emits an odor when rubbed, and especially when sawn but although the odors are similar they are not the same. The same may be said of the odor produced by burning the resin.

When heated in air Mexican amber fuses superficially and then takes fire and burns with a small bright flame of a yellow color and a considerable quantity of smoke. At the same time a faint, pleasant, aromatic odor is emited. If the flame is blown out a white smoke arises from the hot resin which has an irritating effect on the throat and lungs. Heating in a closed tube causes behavior resembling succinite. The resin first melts without darkening. Then froths while a small amount of water condenses in the upper part of the tube. The melting point seems to be lower than that of amber and the resultant liquid seems to be thinner. After a time the frothing ceases and the liquid begins to boil and darken. The decomposition results in the formation of a dark brown, rather viscous oil. Finally a deposit of carbon remains in the tube. On cooling a number of acicular crystals appear in the oil and these are probably succinic acid as they appear exactly like the crystals which are formed from succinite treated in the same way. The quantity of this acid is noticeably less than in succinite however. The oil mentioned above has a decidedly aromatic, but unpleasant, odor.

In the matter of solubility, Mexican amber departs distinctly from Baltic amber as the latter is twenty to eighty per cent soluble in ether, alcohol, chloroform, carbon tetrachloride, carbon disulphide and oil of turpentine. Mexican amber was tested in these solvents in the form of powder and in small fragments . In all cases the solubility was either very small or nonexistant. Carbon disulphide however first caused a slight opalescence which later cleared to such an extent that the resin was clearer than before. At the same time it became soft and like art gum rubber. Chloroform produced a similar effect except that there was no opalescent stage and the softened resin was much less elastic. Also the fragment originally introduced into the solvent was broken into about a dozen smaller ones, apparently by the action of the solvent.

These properties do not correspond with those of any other fossil resin, nor to any recent one either. It is therefore new and deserves a name. I propose the name Bacalite which is a highly abbreviated Baja California plus the usual termination-ite.

In the ultra violet light produced by a photoflood lamp and a Corex A filter, bacalite is highly fluorescent on fresh surfaces but totally inactive on old ones. It seems to be slightly transparent to the rays as the fluorescence extends into the mineral for a depth of 1.5 to 2 millimeters. The color of the light is pale blue, exactly like gedanite and very similar to amber. The non-fluorescent surface formed on exposure is about 0.5 millimeter in thickness.

THE AMATEUR LAPIDARY

Conducted by J. H. HOWARD*

504 Crescent Ave., Greenville, S. C.

Amateur and professional lapidaries are cordially invited to submit contributions and so make this department of interest to all.

*Author of—*The Working of Semi-Precious Stones.* A practical guide-book written in non-technical language for those who desire to cut and polish semi-precious stones.

Display Cases

After your gems are cut and nicely polished do you lose a great deal of their effectiveness through poorly designed displays? The gems have no utilitarian value, their only excuse for existance is the display of such beauty as they may possess and that beauty may be largely hidden if the stones are jumbled together without a proper background and under inadequate light.

A suggested tray which may be readily made by the average "home mechanic" will be briefly described. The arrangement for the display of faceted gems is somewhat different from that best suited for showing off the cabochon shapes but the tray here described is correct for cabochons and with modifications noted later is equally satisfactory for faceted gems. Assuredly there are many other methods of display but this one is chosen as being low in cost, neat, effective and suitable for all types of gems. Dimensions, size of walls, size of partitions, method of holding together, etc., are to be determined by each individual for himself. The writer, for the sake of being specific, will describe the ones he made. If the home shop does not have woodworking machinery it is well to have all the parts planed and the bottoms cut to size in a job wood shop. Red Cedar, Red Gum or Poplar are suitable woods for the job. The material for making 10 trays (4 of them for faceted stones) is:

10 pcs—5/16"x8"x12" Red Gum.

40 lineal feet ½"x⅜" Red Gum for outer walls.

60 lineal feet ½"x¼" Red Gum for partitions.

Six of the trays were made for cabochon shaped stones. The side walls are ½" high and ⅜" thick. These walls are cut to length and put together with ⅝" No. 2 flat head wood screws. Body holes are bored and countersunk for these. The bottom of the box is then fastened to the side walls with the same size screws put in from the back, again drilling and countersinking body holes. The partitions for dividing a tray into four compartments, are then cut carefully to length and anchored in place with 4 screws through the back of the box. The partitions should be made of two pieces of wood mortised together and not of three pieces as might be the impression. Countersink all screw heads at least 1/16". When the assembly is complete dress all the outer walls with a block plane thereby making the side walls join true with the large board that constitutes the bottom. The screw holes can be filled with putty or plastic wood if desired.

To use this tray for cabochon display, cut pieces of white matte board to fit loosely in each compartment. Cement the gems to the matte board, using something like Duco Cement. Leave room where desired for name plates. These may be printed or typed on opaque cloth mending tape and the name plate stuck to the matte board. Avoid crowding the stones. They will

show up better if not more than from 8 to 12 stones are put in each compartment.

This same tray with modified partitions is excellent for faceted gems. Divide each tray into 40 compartments instead of into only four. Five compartments wide by eight compartments long makes a good arrangement. Partitions are to be made of the same material, mortised together in the same way.

The trays having been divided into the desired number of compartments, cut squares of cotton batting about ¼" thick, of just the right size to slip into and to cover the bottoms of each compartment. Form a "nest" in the cotton in the center of each compartment. This nest may be made by using two common pins as tools. Insert them side by side at the center of the cotton and move them away from each other. Do this several times. The fibers will be displaced leaving a snug nest that will hold the gem in an upright position. The size of the nest is to depend on the size of the gem. It should be of such size that the gem will be seated in it up to, but not beyond, its girdle. If the gems are too deep down in the compartments the walls of the compartments will interfere with the entry of light and the gems will lose in brilliancy. If they are too near the top of the compartment stray fibers of cotton will be caught by the bottom of the tray above when the trays are stacked and will disarrange the whole compartment.

Labels for these gems can be printed on paper and stuck down against a side of the compartment where it will be held in place by the cotton.

An enclosing cabinet, in which these trays are stored as drawers, may be readily made of the same kind of wood. This can be a simple box with separator strips fastened on its interior sides to act as supports for the drawers.

A swinging door with hinges, hasp, staple and small padlock of brass add the finishing touches and also protect the gems against carelessness and petty thievery. J. H. HOWARD.

Black Sulphur at Hillburn, New York

By EDWIN ROEDDER

One day, while hunting minerals near the town of Hillburn, N. Y. (near the New York-New Jersey border) I came across a large boulder composed mainly of phlogopite and graphite in quartz, which had been blasted out of the hillside for a road. The thing about this particular boulder which attracted my attention was the occurrence of a cavity in the top, about ten inches long and seven inches wide, and filled with a gray-black powder about the consistency of slightly moistened powdered chalk, being easily broken up with the fingers. I had noticed this same substance in minute amounts imbedded between feldspar crystals and closely associated with pyrrhotite in nearby rocks, but thought it to be merely dirt. Upon testing a little with borax, it took fire, and burned almost clean with a blue flame, little smoke and a strong "sulphur" smell. It proved, without doubt, upon further examination, to be sulphur. It was verified also by Dr. Samuel G. Gordon, at the Academy of Natural Sciences, Philadelphia.

Its occurrence in the boulder was probaby due to the alteration of pyrrhotite, magnetic iron sulphide, with sulphur formed as a by-product. This is further proven by its usual occurrence with this mineral (a little platy pyrrhotite was found deeper down in the sulphur).

At this same locality there are many interesting minerals, among them the following: Graphite (in large flakes and crystals); Coccolite (abundant); Augite (good crystals, large cleavages, etc.); Molybdenite; Phlogopite; Pyrrhotite; Apatite; etc.

Aragonite at Allentown, Penn.

By F. R. FAUX

About five years ago, workmen, at the Ziegenfuss Quarry, at Allentown, Pa., blasted an opening into an underground cave, while removing stone to be crushed for road material. Unfortunately, no one mineralogically inclined, entered the cave, which appeared to be small at that time. In the course of rock removal, the owner did, however, take out some massive white rock which he sold for rock garden material. Later Mr. Allen Heyl got into the cave for a short visit and reported many beautiful formations and several successive chambers each more beautifully covered with stalactites and arborescent formations. Unfortunately again the first five chambers were in the path of rock removal and subsequently were destroyed. About the early part of 1933 the writer was able to explore the remaining rooms and was permitted to remove the easier reached specimens. Many of the best were beyond reach as the main chamber was 25 feet or more in height and about the same in width.

The formations were beautiful, and although the writer has been in many caves, he has seen none that were more attractive. As there are a number of caves in a small radius, the owner did not deem it profitable to commercialize on this one. The easy manner in which the surrounding rock can be quarried and the big demand for it for roads favored this decision.

At present the main chamber is in process of destruction leaving two small chambers as yet untouched but not worthy of mention. There were nine rooms in all, each connected by a small alley or natural tunnel.

No doubt there are more caves nearby but whether or not they connect, will not come to light unless quarrying opens into them at some future date. There are at least eight known caves near this one, that is, within a fifteen mile radius. Some have beautiful formations and are geologically interesting as well. One has a clear lake with fish, but the cave described is the only one that had an abundance of Aragonite. In the others the formations are of calcite.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912.

Of Rocks and Minerals published monthly at Peekskill, N. Y., for October 1st, 1935.

State of New York ,
County of Westchester, } ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Peter Zodac, who having been duly sworn according to law, deposes and says that he is the Editor and Publisher of Rocks and Minerals and that the following is to the best of his knowledge and belief, a true statement of the owneship, management etc., of the aforesaid publication of r the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher Peter Zodac, Peekskill, N. Y.; Editor Peter Zodac, Peekskill, N. Y.; Managing Editor Peter Zodac, Peekskill, N. Y.; Business Manager Peter Zodac, Peekskill, N. Y.

2. That the owner is Peter Zodac, Peekskill, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also in cases where the stockholders or security holders appears upon the books of the company but also in cases where the stockholders or securit holders appears upon the books of the company as trustee or in any other fiduciar relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

PETER ZODAC, *Publisher*

Sworn to and subscribed before me this 11th day of October, 1935.

(SEAL) H. ALBAN ANDERSON,
Notary Public.

(My commission expires March 30, 1937.)

Handbook For The Amateur Lapidary

By J. HARRY HOWARD

140 pp. $2.00

Reviewed by H. ALBAN ANDERSON

"Handbook for the Amateur Lapidary" is the title of a new book, just off the press, written by J. Harry Howard, author of the brief elementary monograph "The Working of Semi-precious Stones," which was issued by ROCKS and MINERALS as its Bulletin No. 1. While the monograph did not pretend to be more than what it was, an elementary introduction to gem and stone cutting, the Handbook is a more ambitious undertaking, being, as the title page informs us, "designed to provide practical instruction in all kinds of gem cutting for the beginner and for the advanced amateur." This Mr. Howard has accomplished in a very adequate manner. Eighty-five of the book's 140 pages are devoted to sawing, cabachon cutting, large flats, gem drilling, bead making, and cutting faceted gems. The remaining ten chapters are concerned with the more advanced art—optics of brilliants, orientation of gem to crystal, mosaics, carving, engraving, diamond polishing, etc.,—which will probably be of interest to the general reader who may be surprised to know there is a right and a wrong way to prepare a crystal for cutting, or who is curious as to how the carving or engraving of the stone in his watchcharm or ring was done.

Gem cutting is one of the oldest arts, but when Mr. Howard desired to try his hand at it and sought information in the public libraries, he could find no literature on the subject. In fact it seemed to be one of those secret arts, the fundamentals of which can be learned only through an apprenticeship under a master whose methods, and often manner of work, differed from those of every other master of the trade. Here was a field for a pioneer, and Mr. Howard stepped into it after a few years of actual experience and experimenting. His monograph was a modest publication. A two-page chapter covered equipment and supplies, with approximate costs; eight pages were devoted to grinding and polishing, four to sawing, two and a half to faceted stones and slabs, with a few pages of notes and suggestions for which no other place could be found. But it set thousands of amateur mineralogists to cutting and polishing stones, and it was surprising how many turned out creditable work after a few months' experience. The monograph is still a good book. The Handbook, however, is the product of a more ripened judgment, broadened experience and much further experimentation. Undoubtedly it is at present the most complete, if not the only, book on the gem cutting art, and will probably continue to be so for another five years, when Mr. Howard may issue another.

As Mr. Howard is considering an art, the Handbook can only point the way. It gives the beginner all the knowledge he requires to do good work; it will lift an advanced amateur out of some of his difficulties. But technique, the artistry of execution after one has learned how the thing is done, must be developed, by the student. For technique is a part, let us say, of our subliminal selves, the subtle something we unconsciously do to a salad or pie, which makes it better than other people's salads and pies, and which we cannot teach to another, nor another learn by observation, no matter how many salads or pies are prepared in his presence. Developing technique may lead to a change of apparatus or methods, but the amateur will need Mr. Howard's book to get a running start.

To Mr. Howard the lapidary's art is greatly indebted, not only for laying the foundation stone for its future literature, but also for opening its closed door to the amateur, who will certainly contribute to this, as he has to all other arts and sciences into whose precincts he has been privileged to enter.

A PEEK AT OUR MAIL

Doesn't Need a Premium

So. Portland, Maine—Forget about the premium! The magazine more than takes care of that.—*Leonard Starbird.*

Better Than a Kansas Farm

Pendleton, Ore.—Enclosed is a postal order for which please continue my subscription to Rocks and Minerals Magazine for another year, as I would not miss a copy for a Kansas farm. I cannot begin to tell how much the little Magazine has done for me. I am now grinding and polishing quite a number of semi-precious stones, and do a fairly good job of it too. Thanks due entirely to the helpful hints and information gleaned from its pages.—*Mrs. Mary S. Vincent.*

A Rocks and Minerals Booster

Clair, Sask., Canada—I am enclosing herewith another year's renewal to the magazine, as I wish it to continue coming every month. It is great to receive a publication that lists localities and sources from which minerals may be obtained. I feel that I can order anything from an Ad. in Rocks *and* Minerals and know I am dealing with reliable parties who had to submit satisfactory references before their Ads. were accepted. No questionable Ads. appear in your columns and I have done business with a number of your advertisers and in each case have been given a square deal.—*J. H. Yerex.*

From His Highness, The Prince

Galle, Ceylon,—I am enclosing a subscription to your magazine, Rocks *and* Minerals. Please send it to my home in India.—*Prince Salie.*

Wouldn't Miss an Issue

Portland, Conn.—Enclosed you will find check to cover renewal of my subscription to your magazine, which I would not want to miss for a single month.—S. A. Montague.

P. L. Forbes, the discoverer of the beautiful iridescent obsidian at Glass Buttes near Stauffer, Oregon, has recently moved from Stauffer to R. 2, Bend, Oregon. Aside from being an ardent mineral collector, Mr. Forbes is Oregon's most famous mineral dealer.

The Geological Outing

Sunday, November 17th, 1935

The first Geological Outing of the Rocks and Minerals Association which will be held in Peekskill on Sunday, November 17th, has awakened quite a little interest among the mineralogists within a radium of 75 miles. Undoubtedly we shall receive the desired postcard from a larger number when it is known that the program has a grand finale in an address by Mr. James G. Manchester of the New York Mineralogical Club, on "The Story of Minerals" with a portion of the lecture devoted to fluorescent minerals. Mr. Manchester will speak in the Ford Auditorium of the Administration Building of the Peekskill Military Academy and the corps of cadets has been invited to be present.

Those attending the outing will meet at the residence of the editor of ROCKS and MINERALS at 157 Wells Street, Peekskill, at 12 o'clock noon. This is almost adjacent to the P. M. A. campus. Any who may arrive after the party has started on its tour of inspection may learn at the house where the party may be at that hour.

The party will then visit localities where the following geological formations will be observed and inspected: igneous, sedimentary, and metamorphic rocks, veins, dikes, faults, contacts, dips, strikes, and glacial phenomena.

It is expected that the party can reassemble at the Ford Auditorium at 3:30 P. M. Mr. Manchester's interesting address will be delivered at 4 P. M. This will give those present an opportunity of walking over the Academy campus and visiting some of the buildings of this historic school which is over 100 years old. An interesting feature of the campus is a hugh oak tree in the angle of the main cadet dormitory building from a limb of which a spy was hung in the Revolutionary War.